Dissociation rates of J/ψ's with comoving mesons — thermal vs. nonequilibrium scenario*

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We study J/ψ comover dissociation processes in hadronic nonequilibrium environments and compare it with a thermal scenario. The space-time distribution of charmonium production points due to $gg/q\bar{q} \to c\bar{c}$ interactions is calculated by microscopically simulating Glauber-type nucleus-nucleus collisions. For the rescattering stage of charmonium states we generate a full hadronic cascade simulation with the Ultrarelativistic Quantum Molecular Dynamics, UrQMD, model [1] employing fixed dissociation cross sections, $\sigma_{J/\psi M} = 2.41$ mb.

J/ψ dissociation is studied in very central Pb+Pb reactions ($b = 0$) at $E_{\rm lab} = 160$ GeV. Comover dissociation processes occur most frequently about 1 fm/c after the nuclear reaction begins, with a dissociation rate of more than 0.1 c/fm. However, it is dropping rapidly, an order of magnitude within the first 10 fm/c of the reaction. The average collision energies are highest in the early stage of the reaction where the rates are also at their maximum, see Fig. 1. The rates in the later stage of the reaction when $t > 2$ fm/c, correspond to a temperature of $T = 140 \pm 20$ MeV in an equilibrated system. The temperatures one would deduce from the collision energies of Fig. 1 roughly agree with these values. Thus, the concept of a thermal hadron gas may be approximately valid in the later stage of a nuclear reaction. The survival probability of charmonium states, however, is to a large extent determined by the early reaction dynamics, $t \approx 1$ fm/c. Here, the rates roughly correspond to a thermal π and ρ gas with $T \approx 220$ MeV. In contrast, the collision energies at this early time would correspond to temperatures greater than 800 MeV in an ideal thermal hadron gas.

Scatterings of the J/ψ's with π's and ρ's are the dominant dissociation processes. However, together they are responsible for only 37% of the total comover absorption. Many different channels involving heavier meson resonances account for the larger fraction of the total absorption. Those channels would be negligible in an equilibrated environment. It is thus questionable if a model of J/ψ-comover absorption which includes only the light mesons can be used for reasonable quantitative predictions.

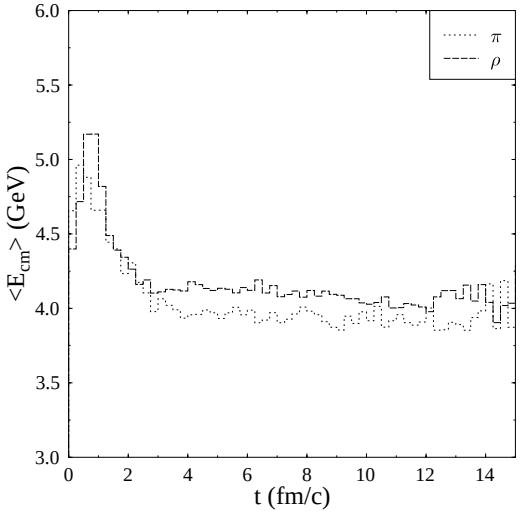

Figure 1: Average J/ψ-meson collision energies as a function of time for $J/\psi\,\pi$ (dotted line) and $J/\psi\,\rho$ interactions (dashed line).

[1] S.A. Bass *et al.*, Prog. Part. Nucl. Phys. 41 (1998) 225.

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